NOAA Technical Memorandum NWS SR-76

USE OF LINEAR REGRESSION EQUATIONS TO ESTIMATE MINIMUM TEMPERATURES OVER PENINSULAR FLORIDA

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September 1974

UNITED STATES DEPARTMENT OF COMMERCE
Frederick B. Dent, Secretary

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
Robert M. White, Administrator

National Weather Service
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1. INTRODUCTION

Wallis (1971) determined the feasibility of using multi-regression techniques to estimate the minimum temperature at a specific location given the minimum temperature at three other locations in a reasonably homogeneous area, climatologically. As a result of this work a project was undertaken to develop equations relating each existing fruit-frost station (305 in number) to three "key stations".

2. PROCEDURE

Fourteen "key stations" were chosen to serve as the basis for dividing the Florida peninsula into triangles which hopefully would bound climatologically homogeneous areas. There was little choice in the selection of these stations since they had to be points from which there would be quick, easy recovery of a reliable minimum temperature on a daily basis, if the equations were to be of any value in real time. Thus most of the "key stations" are either National Weather Service stations or Agricultural Research Centers of the University of Florida (Fig. 1). Each fruit-frost station within or near a described triangle was correlated with the three "key stations" making up the triangle. All of the work was done by computer. Data that went into establishing the constants and subsequently the linear relationships was taken from 42 nights during the winter seasons (November through March) of 1969-70 and 1970-71. In selecting a night to be used in the sample it had to qualify as a "cold night". A cold night by our definition is any night on which the minimum temperature reaches 36°F or lower at any one of the official fruit-frost stations on the Florida peninsula. However, all nights chosen for the sample far exceeded the simple criteria, i.e., they were generally nights that were cool or cold over all of the peninsula.

The final computer-built relationships were of the form

$$T = m_1x_1 + m_2x_2 + m_3x_3 + b$$

where x_1, x_2, x_3 are the independent variables (the minima at the key stations) and T is the expected value of the minimum temperature at the fruit-frost station. The constants m and b may be either positive or negative. Table 1 shows the equations for the Lower East Coast fruit-frost district. The correlation coefficients for the 305 equations range from .77 to .99: 87% are greater than .90. Standard deviations for error range from 1.0°F to 3.6°F.

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*now assigned to WSFO, New Orleans

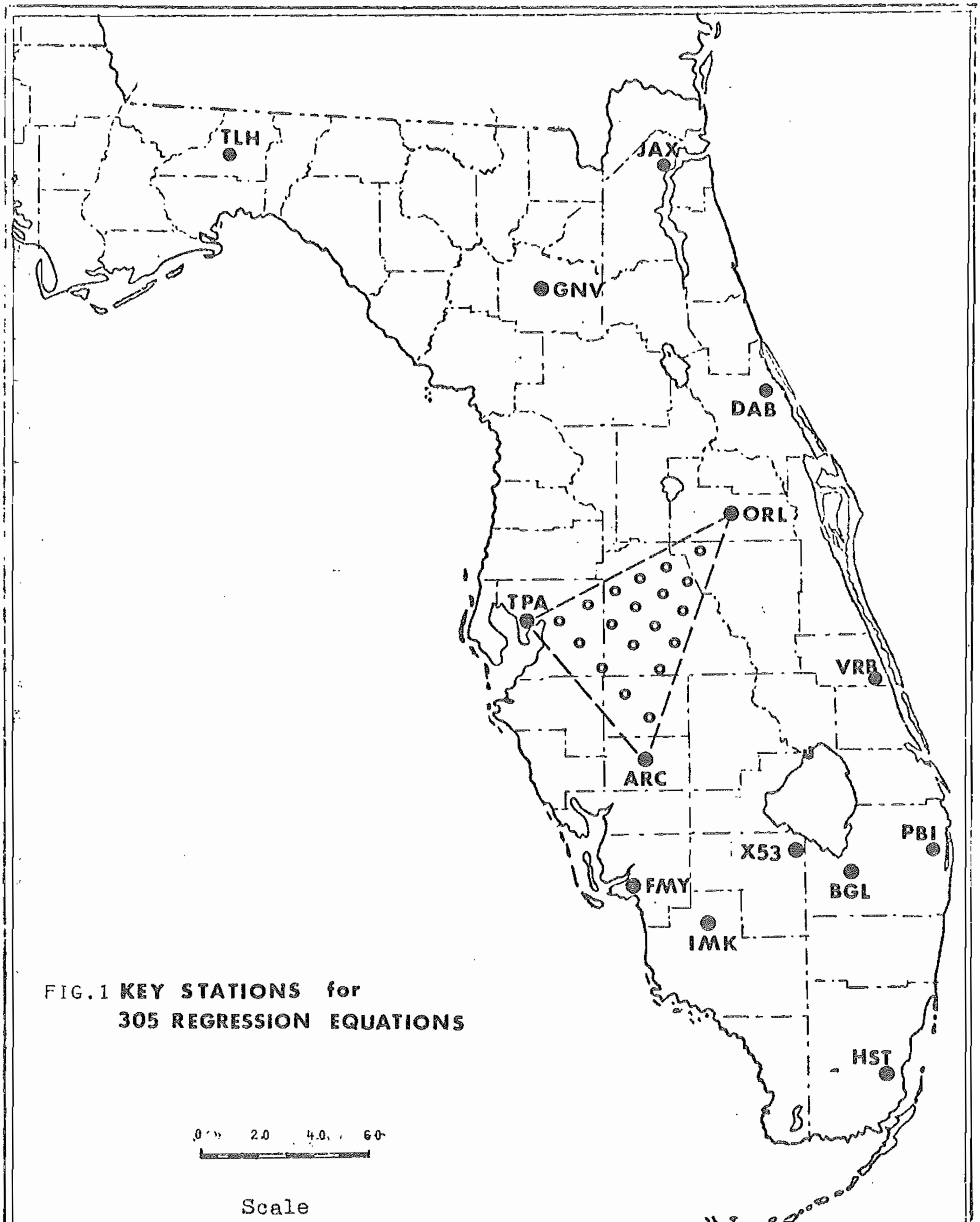


FIG. 1 **KEY STATIONS for 305 REGRESSION EQUATIONS**

TABLE 1

Multiple Regression Equations for the <u>Lower East Coast</u> District

	STATION	EQUATION*
4241	Libby Grove	$Y = -.02680X_1 + .85085X_2 + .02172X_3 + 5.67167$
4342	Mounts Bldg	$Y = .07305X_1 + .80674X_2 + .08937X_3 - .17787$
4441T	Flying Cow	$Y = -.09162X_1 + .77053X_2 + .24302X_3 + 1.07280$
4541T	W Boynton	$Y = .62428X_1 + .05761X_2 + .31909X_3 - 1.08172$
4542T	Hypoluxo	$Y = .78065X_1 + .12246X_2 + .05888X_3 + .51839$
4543-A	Miner Grove	$Y = 1.10418X_1 - .03840X_2 - .12412X_3 + 3.84326$
4642-A	Delray Rd	$Y = .69432X_1 - .10355X_2 + .35461X_3 + 2.57434$
4742T	Delray Fcst	$Y = .65023X_1 + .20297X_2 + .09380X_3 + 2.26370$
4842-B	Pompano Mkt	$Y = .58162X_1 + .07053X_2 + .33671X_3 + 2.23418$
4842-C	N Pompano	$Y = .74704X_1 + .10884X_2 + .19185X_3 - .41067$
4941	Plantation	$Y = .54599X_1 + .20237X_2 + .23673X_3 + 1.76080$
4942	Ft Lauderdale CO	$Y = .24127X_1 + .37597X_2 + .35150X_3 + 3.89882$
5040	Davie	$Y = .34373X_1 + .31804X_2 + .31955X_3 + .63506$
5041-A	Pine Island	$Y = .25593X_1 + .34929X_2 + .40886X_3 - 1.19415$
5041-C	Ft Laud Exp Sta	$Y = .60879X_1 + .33588X_2 + .09224X_3 - 2.24635$
5341	Miami Airport	$Y = .34944X_1 + .04994X_2 + .55848X_3 + 6.11332$
5540-A	Chapman Field	$Y = -.01416X_1 + .50110X_2 + .67310X_3 - 4.61164$
5540-B	South Miami	$Y = -.00234X_1 + .38524X_2 + .67749X_3 - 1.51517$
5638	Homestead Fcst	$Y = -.23438X_1 + .39240X_2 + .90228X_3 - 4.04678$
5639	W Perrine	$Y = -.24936X_1 + .41943X_2 + .91453X_3 - 4.10959$
5640	Princeton	$Y = .03983X_1 + .29156X_2 + .70728X_3 - .79810$
5740T	E Glades	$Y = -.03476X_1 + .36946X_2 + .71181X_3 - 2.25757$

* X_1, X_2, X_3 are the observed minimum temperatures at West Palm Beach, AP, Belle Glade and Homestead Ex Stations respectively... <u>except that</u>

X_1, X_2, X_3 are the observed minimum temperatures at Vero Beach, West Palm Beach and Belle glade respectively for the first three stations on this list.

3. RESULTS

The equations have been used on independent data during the winter seasons of 1972-73 and 1973-74. The histogram in Fig. 2 shows the distribution of errors for 5423 observations during the 1972-73 winter. The mean of this distribution is zero with the standard deviation 2.5°F. Ninety-five percent of the errors are within two standard deviations of the mean. Fig. 3 shows the distribution of errors for 3418 observations during the 1973-74 season. The mean of this distribution is zero with standard deviation 2.7°F. Ninety-five percent are within two standard deviations of the mean and 81% are within one standard deviation. Similar histograms for individual nights were constructed for the 1973-74 season. They were similar in all respects to the composite histogram.

4. DISCUSSION

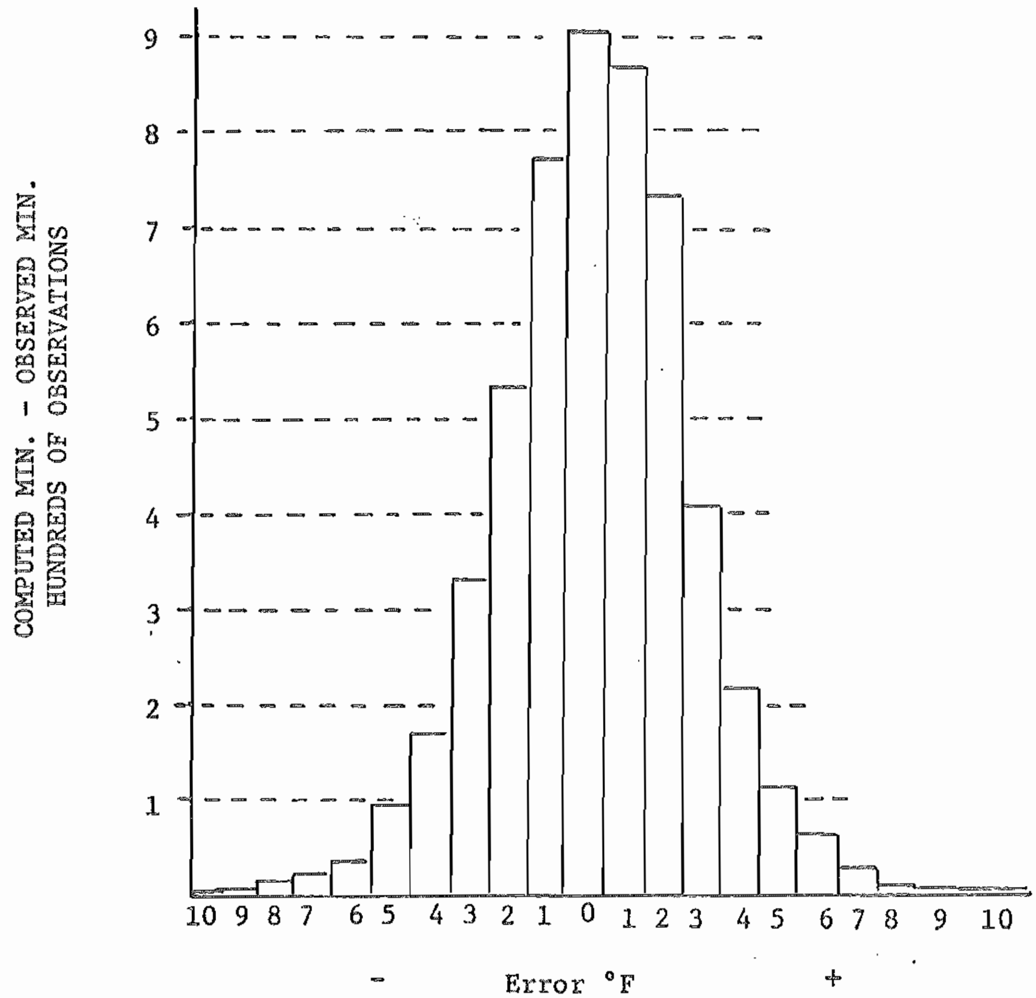
The equations serve two important purposes. First, they provide an excellent estimate of the peninsular-wide minimum temperature field within minutes of the entry of the minimum temperatures from the key stations on the teletype network. There is always a great demand for this information after freezing weather. Second, they provide excellent estimates of the expected value of the minimum temperature in many groves and fields when forecasts of the minima for the 14 key stations are reasonably accurate. This introduces a significant amount of objectivity into the general forecasts of minimum temperature range for the various fruit-frost districts of the peninsula. The equations are especially helpful to the inexperienced forecaster who, by virtue of his training and orientation, may be quite proficient at forecasting the minimum temperature at regular NWS stations but does not have the experience or understanding to relate these to the fruit-frost stations, each with peculiar local influence effects.

While small scale influences in the general weather regime may result in errors, more than two or three standard deviations on occasion, these are rare and do not significantly detract from the usefulness of the equations.

The equations have made possible a further significant reduction in the number of fruit-frost stations needed to provide service and verification, and thus have greatly enhanced the efficiency of the Florida fruit-frost program.

REFERENCES:

Wallis, W. R., 1971. Use of Linear Regression Equations to Estimate Minimum Temperatures over Peninsular Florida. Unpublished, WSO Lakeland Library.



Error °F
1972-73 Data

FIG. 2

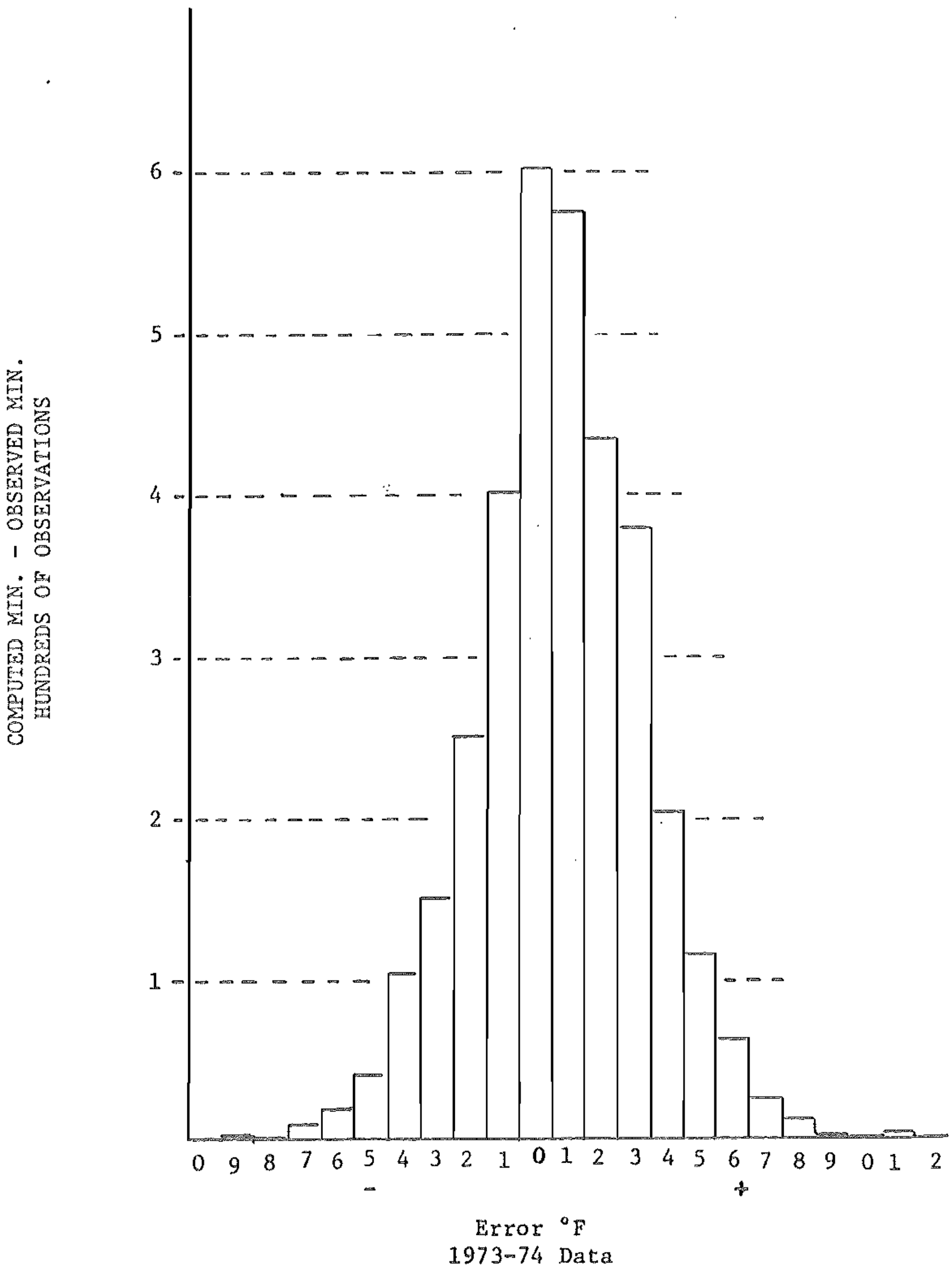

COMPUTED MIN. - OBSERVED MIN.
HUNDREDS OF OBSERVATIONS
6
5
4
3
2
1
0 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 0 1 2
-
+
Error °F
1973-74 Data

FIG. 3